Genetic parameters for claw disorders in Dutch dairy cattle and some relationships with conformation traits.

E.H. van der Waaij[1,2], G. de Jong[3], M. Holzhauer[4], C. Kamphuis[2], and E. Ellen[2]*

[1]Department of Farm Animal Health, Veterinary Faculty, University of Utrecht, POBox 80127 3508 TC Utrecht, The Netherlands Email: E.H.vanderwaaij@vet.uu.nl
[2]Animal Breeding and Genetics Group, Wageningen University and Research Centre, POBox 338, 6700 AH Wageningen, The Netherlands; NRS, POBox 454, 6800 AL Arnhem, The Netherlands; [4]Animal Health Service, POBox 9, 7400 AA Deventer, The Netherlands.

Disturbed claw health is one of the major problems causing production loss and reduced animal welfare. In this study, claws of lactating cows and heifers in 430 herds were trimmed by hooftrimmers and the health status of the hind claws were recorded. Considering only herds with >75% of the animals trimmed, this resulted in records on 21,611 animals. Eight claw disorders could be distinguished, varying in prevalence from <1% (interdigital phlegmona) to ~40% (acute laminitis). In total, >70% of the animals had at least one claw disorder. Conformation traits (incl. locomotion) were recorded during the animal's first lactation. Heritabilities were estimated using a sire model, and ranged from <0.01 (interdigital phlegmona) to 0.10 (digital dermatitis and interdigital fibroma). Genetic correlations between claw disorders and locomotion were high, ranging from 0.13 (acute laminitis) to –0.91 (chronic laminitis). Correlations with the rear leg conformation traits were lower, ranging from 0.04 (interdigital fibroma with rear leg side view) to –0.69 (interdigital phlegmona with rear leg hind view).

Introduction

Claw disorders are an important source of impaired welfare in Dutch dairy cattle. At present, over 70% of the animals have at least one claw disorder (current research). The economic importance of claw disorders is considerable, with 25-30% of the dairy cows treated per year across countries (Boettcher et al., 1998; Politiek et al., 1986; Smit et al., 1986), mainly during the high productive period in the lactation (Blowey and Weaver, 1991; unpublished results from the current research).

The fact that claw disorders are an important cause of increased costs, production loss, and increased culling was reason for the Dutch Animal Health Service (GD) to look into the possibilities to develop a management tool for dairy farmers. This tool should provide insight in the claw health of cows on the farm. Also the Dutch Dairy Cattle Syndicate (NRS) was interested in developing such a tool to look into the possibilities to select for improved claw health. The GD set up a large screening of cattle by instructing hoof trimmers to collect the data during their routine visits to the farms. The NRS provided the pedigree information and conformation scores.

Apart from improving management, claw disorders may be improved through selection. This could be direct selection on the claw health score, though this would require a regular data collection of claw health in the population. It would have to be investigated how frequent the claw health would have to be recorded per animal. Another option could be indirect selection on (already recorded?) traits such as claw, leg or, possibly, udder conformation. Successful indirect selection would require a substantial correlation between the conformation trait(s) and the most important claw disorders. In all cases, accurate genetic parameters are required. Even though genetic parameters of claw disorders have been estimated before (e.g. Baumgartner and Distl, 1988; Reurink and Van Arendonk, 1987; Smit et al., 1986), it usually was with low accuracy and/or only for a limited number of disorders or parities.

Aim of this research was to use the uniquely large data set and estimate genetic parameters for the claw disorders, as well as correlations between the claw disorders and conformation scores.

Materials and methods

Claw health data was collected on 27,198 (close to) lactating cows by 39 professional claw trimmers during their normal visits to 466 Dutch dairy farms in the period May 2002 – October 2003. The health status of the claws of

the hind legs were registered by recording the presence or absence of a disorder, resulting in prevalence records of eight claw disorders. Each cow was only recorded once. Note that some cows had more than one disorder, so that the prevalence records do not reflect the percentage of cows with a claw disorder.

For the analyses, the data was restricted to animals with at least 75% Holstein Friesian (HF), that were present in herds where at least 75% of the cows were trimmed, resulting in 21,611 records in 430 herds.

Conformation data is routinely recorded by trained classifiers in a large proportion of the population, usually during their first lactation. In this research four of those traits related to feet and legs are included in the analyses: rear leg hind view, rear leg side view, foot angle, and feet and legs index. In addition, since 2001 locomotion was recorded at less regular basis on animals that were conformation scored. Note that trimming records are very close to the locomotion recording in those cases.

Statistics

The binomial claw data and the conformation data were analysed using a sire model and restricted maximum likelihood in ASREML (Gilmour et al., 2001). Correlations were obtained from multivariate analyses. Different models were used for analysing claw health and conformation traits. For claw health:

$$Y_{ijklmnop} = \mu + P_i + L_j + B_k + S_l + (H * S * T)_{lmn} + a_o + e_{ijklmnop}$$

where Y is one of the claw disorders, μ is the overall mean, P_i is the fixed effect of the *i*th parity (i=1-5), L_j is the fixed effect of the *j*th lactation stage at the time of trimming (j=1-8), B_k is the fixed effect of the *k*th breed class (k=1-4), S_l is the fixed effect of the *l*th scoring period (l=1-8), $H_m*S_l*T_n$ is the interaction of the *m*th herd (m=1-430) with the *l*th scoring period and the *n*th claw trimmer (n=1-39), a_o is the random animal effect and $e_{ijklmnop}$ is the random error term.

For the conformation traits:

$$Y_{ijklmnopqrs} = \mu + CS_i + L_j + B_k + YS_l + A_m + G_n + (H * D * C)_{opq} + a_r + e_{ijklmnopqrs}$$

where Y is one of the conformation traits, μ is the overall mean, CS_i is the fixed effect of the *i*th conformation standard (i=1-2), L_j is the fixed effect of the *j*th lactation stage at the time of scoring (j=1-521), B_k is the fixed effect of the *k*th breed class (k=1-4), YS_l is the fixed effect of the *l*th year-season (l=1-53), A_m is the fixed effect of the *m*th age in months at the time of scoring (m=1-), G_n is the fixed effect of the *p*th period of birth (p=1-7), $H_o*D_p*C_q$ is the interaction of the *o*th herd (m=1-430) with the *p*th date of conformation scoring (p=1-1404) and the *q*th classifier (n=1-35), a_r is the random animal effect and $e_{ijklmnopqrs}$ is the random error term.

Results and discussion

Heritabilities and Prevalence

In Table 1 are the heritabilities and the prevalences for the eight claw disorders recorded in this research. In total more than 70% of the animals had at least one disorder. Three disorders occurred frequently so that the information content of the data for those traits was reasonable high. The other traits occurred much less frequently, most likely because of environmental reason, making it more difficult to estimate the genetic background of the trait. The heritability of 0.10 for interdigital fibroma can therefore be considered rather high.

Table 1. Heritabilities and Prevelances of trait related to claw health

	h^2 (s.e.)	Prevalences %
Acute laminitis (AL)	0.05 (0.01)	39.9
Interdigital dermatitis (ID)	0.08 (0.02)	38.7
Digital dermatitis (DD)	0.10 (0.02)	21.7
White line lesion (WL)	0.02 (0.01)	9.6
Interdigital fibroma (IF)	0.10 (0.02)	5.9
Sole ulcer (SU)	0.01 (0.01)	5.4
Chronical laminitis (CL)	0.01 (0.01)	4.1
Interdigital phlegmona (IP)	0.004 (0.003)	0.6

It should be noted that acute and chronic laminitis may be partly interchangeable as the hoof trimmers did not always agree on what was acute and what chronic. Also, they may have missed some of the chronic cases as the claws often are dirty so that the typical rib on the claw can easily be missed. Interdigital phlegmona is an infectious disease that is very painful for the cow, but appears and disappears in a matter of days. The

prevalence rate as presented here thus is not necessarily representing the size of the problem.

In general it can be concluded that the heritabilities are low, indicating a large influence of the environment in comparison to that of genetics. In the case of infectious disorders, prerequisite for expression of the trait of course is the presence of the pathogen. However, nutrition, housing, and general condition of the cow will be very important factors as well. For example, acute laminitis always occurs in combination with rumen acidosis, usually during the first part of the lactation.

Genetic correlations claw health

In Table 2 are the genetic correlations between the traits related to claw health. The traits are presented in the order of prevalence. The high correlation between digital and interdigital dermatitis (0.74) is as expected as the infection both areas are very near to each other. Acute laminitis is a relatively short event but often leads to chronic changes in the pododerm and the pedal bone, due to intense congestion of laminar blood vessels under the claw wall (Blowey and Weaver, 1991; Politiek et al., 1986). Chronic laminitis may lead to an increased susceptibility for sole ulcers and white line lesions (Politiek et al., 1986). The high genetic correlations between acute laminitis and sole ulcer (0.81) and between chronic laminitis and sole ulcer (1.00) thus seem logical. The high correlation between sole ulcer and white line lesion (0.95) is more difficult to explain as the correlations between white line lesion with acute laminitis (0.30) and chronic laminitis (0.33) seem to suggest otherwise. It is unclear how much value should be given to the correlations with interdigital phlegmona as the prevalence of IP is very low and, consequently, chance may play an important role. The error correlations between the traits considered were low and ranged from -0.03 to 0.10 (results not shown).

Table 2. Genetic correlations between traits related to claw health

	ID	DD	WL	IF	SU	CL	IP
AL	0.13	-0.12	0.30	0.13	0.81	0.63	0.15
ID		0.74	0.12	0.67	-0.11	0.73	0.22
DD			0.08	0.47	-0.18	0.12	0.37
WL				0.34	0.95	0.33	0.00
IF					0.18	0.58	0.90
SU						1.00	0.38
CL							-0.33

Genetic correlations with conformation traits

Conformation is scored on a routine basis in a large percentage of the Dutch dairy cattle population during the first lactation of the cows. Thus a large database is available with records on for example leg and udder traits. These traits may serve as indicator traits for claw health, so that the actual claw health not necessarily needs to be monitored. This would be cost efficient. Also, animals that are kept in an optimal environment and, consequently, are less exposed to factors that disturb claw health, could still be monitored for their potential regarding resistance to various claw disorders.

Conformation of hind leg rear (RV) and side view (SV), foot angle (FA) and a feet and leg index (FL) are routinely scored on all animals. We also have locomotion scores (LO) obtained during the routinely conformation scoring on part of the animals since 2001. This trait will be monitored routinely, but at this stage we only have information on relatively young cows (i.e. short time between conformation scoring and hoof trimming). Results in Table 3 suggest that locomotion is a good indicator for many of the claw disorders. As there is only data available on young cows, it remains important to validate locomotion as an indicator trait in the future. Foot angle has a high correlation with white line lesion. However, as foot angle most likely is an optimum trait, it is not obvious how to interpret these correlations.

Table 3. Genetic correlations between traits related to claw health and some conformation traits

	RV	SV	FA	LO	FL
AL	0.14	0.13	0.11	0.13	0.26
ID	-0.10	0.27	-0.31	-0.71	-0.24
DD	-0.21	0.16	-0.22	-0.67	-0.34
WL	-0.12	-0.19	0.64	-0.04	0.01
IF	-0.35	0.04	-0.15	0.82	-0.35
SU	-0.07	0.16	-0.05	-0.04	-0.31
CL	0.22	0.20	0.36	-0.91	-0.32
IP	-0.69	0.28	-0.23	-0.19	-0.31

The correlations with udder traits as scored during first lactation have not been estimated yet. Also, it is likely that animals with a very large udder will put more pressure on the outer claws and thus are prune to have more claw disorders than cows with a small

udder. It would be interesting to record udder conformation during first and later lactations (e.g. at the time of trimming), and calculate the correlation with claw health.

Conclusions

Locomotion seems a good indicator for most claw disorders. Its value should be validated in the future as more records will be available, also with locomotion scoring and hoof trimming multiple lactations apart.

Further research is needed to determine which traits would be best indicators (e.g. udder traits), and to investigate to what extend selection could be successful without having to collect claw health data.

Acknowledgements

We would like to thank the hoof trimmers for putting so much effort into collecting high quality data.

References

Baumgartner, C. and O. Distl. 1988. *Possible selection strategies to improve claw soundness by claw measuements*. Paper presented at the EAAP- working group "claw quality in cattle" at Veldhoven, The Netherlands, 11-14 Sept. 1988.

Blowey, R. W. and A. D. Weaver. 1991. *Diseases and disorders of cattle*. Wolfe Publishing Ltd. Aylesburry. p:89-128.

Boettcher, P. J., J. C. M. Dekkers, L. G. Warnick, and S. J. Wells. 1998. *Genetic analysis of clynical lameness in dairy cattle*. J. Dairy Sci. **81:** 1148.

Gilmour, A. R., B. R. Cullis, S. J. Welham, and R. Thompson. 2001. *ASREML Reference Manual*. NSW Agriculture, Orange, Australia, September 2001.

Politiek, R. D., O. Distl, T. Fjeldaas, J. Heeres, B. T. McDaniel, E. Nielsen, D. J. Peterse, A. Reurink, and P. Strandberg. 1986. *Importance of claw quality in cattle: review and recommendations to achieve genetic improvement.* Report to the EAAP working group on claw quality in cattle. Livest. Prod. Sci. **15:** 133.

Reurink, A. and J. A. M. van Arendonk. 1987. Relationships of claw disorders and claw measurements with efficiency of production in dairy cattle. Polycopy, 38th meeting of the EAAP, Lisbon, 28 Sep- 1 Oct 1987.

Smit, H., B. Verbeek, D. J. Peterse, B. T. McDaniel, and R. D. Politiek. 1986. *Genetic aspects of claw disorders, claw measurements and 'type' scores for feet in Friesian cattle.* Livest. Prod. Sci. **15:**205.